SURVEILLANCE OF VECTOR PROBLEMS ON A NATIONAL BASIS AS EXAMPLIFIED BY IRAN *

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ABSTRACT **The significance and impact of the arthropods and other vectors, as diseases-transmitting agents and human pests, on human health need not to be over emphasized. The increasing changes of the total environment accompanied with the changes in the ecology of vectors have made such impact a more complex and dynamic one.**

To meet the problems caused by these changes, a quantitative and qualitative knowledge of vector characteristics such as, presence or absence, species, densities, distribution and dispersal, biting habit, infection rate, etc. are necessary. These informations should be available on local, regional, national and international basis.

In the present paper, various aspects of such information system (surveillance) including network, personnel, methods etc .. are reviewed in general. Examples from Iranian experiences in the cases of malaria vectors, sandflies, fleas and snails are also presented and illustrated.

The importance of vectors as human pests or as disease-transmitting or carying agents and the necessity for meeting with the problems posed by them, particularly with regard to the serious new developments in the area of vector ecology and vector control, such as the folowings need not to be over emphasized: (1, 2, 4, 6, 11, 15, 21, 22)

— Increased areas of the world brought under irrigation, creating huge new areas that are highly favour-

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able for the development of large mosquito population;

- Marked increase in the number and size of towns and cities without proper development of such facilities as sewage disposal and piped water supplies, which help to prevent the establishment of the new vector habitats;
- The development of resistance to chemical pesticides in many species of vectors, because of the wide application of these materials for public health and agricultural purposes;
- Specific behavioural changes of vectors and the resulting alteration in the dynamics of vector-parasite-man-animal and environment inter-relationship;
- Danger of introduction or re-introduction of vectors and establishment or re-establishment of vector-borne diseases in the areas free or freed from them, particularly the potentially receptive and vulnerable areas;
- Development of rational evaluation system for vector control or vector eradication programmes.

The need for certain numerical values in the assessment of the transmission dynamic of vector-borne diseases has been pointed out by MacDonald (12). There has been a progressively increasing demand for new and precise quantitative data about vector population, distribution and behaviour in order to develop vector control programmes on a much sounder basis, to evaluate the effect of various types of control schemes on more accurate ways, and to standardize the epidemiological and entomological techniques to enable the comparative study and judgment of vector problems on national, regional and possibly on international basis.

In order to make this type of data available, with such a degree of coverage, diversity and preciseness, as required for proper use and application, it is advisable that a system of regular entomological observations, i.e., "Periodic Survey" or "Surveillance" of vector problems be established within the respective area. The term surveillance within the context of vector ecology, means a regular periodical search for a particular vector, or for a particular aspect of the vector problems with special epidemiological application and significance.

The general objectives of such surveillance, in addition to the specific purposes related to a particular vector, are as follows: 5, 16, 21, 23.

- Presence or absence of a known vector;
- Identity of vector and non vectors;
- Distribution and seasonal incidence, vector dispersion
- Biting habits in relation to man (man-vector relationship);
- Biological characters and behavioural changes of particular importance;
- Population estimates, including:
  - vector density (various stages)
  - relative and absolute population (various stages)
  - natality and mortality, life budget (life table)
  - dispersal (quantitative approach)
  - Infection rate;
  - Assessment of the efficacy of various control measures;
  - Level of susceptibility to insecticides;
  - Environmental factors (climate, breeding places, etc.) and their relation to vector population dynamics;
  - Determination of the areas receptive to particular vectors, and the danger of re-establishment of a vector-borne disease or occurrence of outbreaks and epidemics, with particular attention to the degree of receptivity or vulnerability.

The above objectives can be ascertained through the implementation of a series of entomological techniques. While the methodology varies in different projects and are adopted to various vectors or vector problems, a certain degree of standardization of techniques and recording of entomological data is required. However, there are many factors that must be taken into account in any entomological observation or vector surveillance programme, such as:

Time and space coverage — sufficient sampling of observation areas and units — methods of collection of vectors (all stages) and estimation of their population — reliable and easy applicable techniques for determination of the age composition — feeding and man-biting habits — infection rate — susceptibility to insecticides — behavioural changes, etc.

Training of personnel in relation to types and duration — organization and administration of the work including also the system of supervision, coordination and reporting.

Integration of epidemiological and entomological investigations to ascertain a better and more appropriate epidemiological and operational significance. 9, 13, 18

The world experience on surveillance of vectors and vector problems is not very limited. The world wide malaria control and eradication programmes have furnished a significant volume of knowledge on malaria vectors, which is standardized, coordinated and exchanged through the good office of the World Health Organization. 20

Information circulars on insecticide resistance is another example of the world efforts towards the reconnaissance and meeting the problem of arthroped resistance to insecticides. 10

In addition, observation on :

Aedes aegypti and yellow fever in the Americas and Africa; *Culex fatigans* and Filariasis in Rangoon; *Tse-Tse flies* and Trypanosomiasis in Africa; *Fleas* and Rodents and plague in many parts of the world; *Snails* and Bilharziasis in Africa, South America and the Middle East; *Sandflies* and leishmaniasis in many countries, and *Simuliidae* and Filariasis (Onchocerciasis) in Africa, are other good examples of this type of experience.

EXPERIENCES OF IRAN

The public health importance of the arthropods in Iran as human pest or as disease transmitting agents, and the impact on the Geographical Pathology of the country is great and significant.

Up to now 406 species of arthropods, snails and rodents have been identified from Iran, including 22 species of Anophelines (7 vectors), 22 Culex species (many suspected vectors), 4 species of Aedes, 2 species of Theobaldia, 42 species of sandflies (8 vectors), 36 species of Culcoides, 85 species of Tabanidae, 103 species of Fleas (2 proved vectors), 8 species of Argasidea (3 vectors), 22 Ixodidae species (many suspected as vectors or carriers), 12 species of snails (2 vectors) and 42 species of Rodents (many reservoir of anthropozoonotic agents).

The occurrence of many diseases with significant actual or potential public health importance has been described in Iran, namely : malaria, sylvatic plague, visceral and cutaneous leishmaniasis, tick-borne relapsing fever, urinary bilharziasis, arthropod-borne virus infections, etc.

Some of the above diseases (malaria, bilharziasis) have received priority within the national health plan, so they have been put under special programmes, requiring regular and longitudinal operations (including entomological and epidemiological surveillance). Some others (sylvatic plague, leishmaniasis) because of their very interesting epidemiological features, have received attention from the research point of view, needing also some kind of longitudinal studies, including surveillance of the vector problems.

1- SAND FLIES

Although there is no control programme on a national basis against leishmaniasis in Iran, surveillance of the vector has been under operation for years in areas under investigation for this disease (by the Institute of Public Health Research).

Sandflies have always been a difficult group to sample, as distinct from just capturing. There are several methods of catching, collecting or trapping *Phlebotomus* and demonstrating apparent changes in species composition at different seasons, but it is still uncertain as to how much these captures, often restricted to specially favourable concentration sites, really reflect changes in the density of population as a whole, or give anything approaching a true idea of vector distribution.

There are various methods, cited for the collection of sandflies, such as: 17

- Trap huts (built by man and animals)
- Rodent baited cage
- Sticky trap
- Indoor collection (direct capture)
- Indoor collection by total catch method (space spraying)
- Sticky band across burrows and other agregation sites
- Light trap

In our experience the mtehods of surveillance are essentially based on sampling population of vectors, and this is usually done by collecting them with aspirators or sticky traps.

1-1. SAMPLING VECTOR POPULATION BY ASPIRATION

This is based on the sampling of two to ten per cent of the villages (depending on the size of the area), and samling of ten to twenty fixed catching stations in each village (depending on the size of the villages) in which the collection of sandflies will be carried out once a week. Usually a collector spends fifteen minutes in each station, and collection is done in the same part of the day, preferably always at the same hour.

1-2. SAMPILNG VECTOR POPULATION BY STICKY TRAPS

Sticky traps may be used in the same type of locations de cribed above, or in the courtyard of the houses.

This method is also used to determine the season varation of the density of wild sandflies in rodent burrows stone heaps at the foot hills.

Collection is done once a week in ten to twenty fix stations which are marked by oil paint. Each time, traps are p at the same place at the sunset and they are collected early the morning. Sandflies collected each time are put in a separa tube, and later their species will be identified and recorde Variation of the density of each species is recorded separate because each species has a different significance. It is advisab to use both these methods at the same time, because one metho may give the highest catch for one or two species, while th other method may have better results as regards other specie

1-3. COLLECTION BY MOSQUITO NET

When we want to catch live sandflies from rodent burrows, v use this method. We hang a somewhat large mosquito net (with out floor) over several holes of a colony, about 30 minutes befo sunset. We blow cigarette smoke in the holes by an aspirator an this will make sandflies come out of the burrow. They sit on th walls of the mosquito net, and then we are able to collect ther by aspirator. It is also possible to use smaller nets fixed at th end of a funnel put downward on each opening, but this usual does not give satisfactory results.

1-4. DETERMINATION OF THE INFECTION RATE

All the above three methods are used for the determination o the infection rate. Here again, we need to have fixed catchin stations and to carry out collections every time at the same plac otherwise we will not be able to find the seasonal fluctuation o the infection rate of sandflies.

1-5. SUSCEPTIBILITY TESTS

These tests are done with the same kit used for the tests on mos quitoes. The only difference is that we have to change th upper net of the holding tubes to finer ones to prevent escapin of sandflies.

Domestic sandflies are collected by aspirator and wil sandflies by mosquito net, for determination of their level o susceptibility, because we need live sandflies for this purpos

1-6. PRACTICAL IMPLICATIONS OF THE SURVEILLANCE OF SANDFLIES

In any programme aimed for the control of leishmaniasis, we need to have some correct information about the sensity of domestic and wild sandflies, their seasonal variation, infection rate and their changes in different seasons, suceptibility of the vectors, and so forth. By using the above mentioned techniques, we will be able to provide the interested authorities with this information and to evaluate the progress and efficiency of the control measures at the local and national level.

The organization and manpower needed for such surveys depend on the extent of the problem and the size of the area. With regard to the epidemiology and peculiar distribution of leishmaniasis, at least under the prevailing conditions of Iran, the organization of sandfly surveillance should follow the foci of disease. Usually, a team composed of one technologist, or senior technician (with sufficient knowledge and experience of the problem and related techniques) assisted by two field technicians, is sufficient to collect information about one focus. If the number of foci in one large geographical, ecological or administrative area is more than one, then one senior entomologist should supervise and assist two or three teams.

However, the nature of the work on sandflies is such that it cannot be completely integrated with other entomological, or even mosquito surveys, but on a long run, some kind of coordination should exist between them.

2- ANOPHELINES AND MALARIA

The role of entomology in various stages of malaria eradication and the importance of the anopheline problems as an integral part of the epidemiological surveillance or vigilance in the late attack, consolidation and maintenance phase of malaria eradication programmes, especially in problem receptive and vulnerable areas, need not be over emphasized and reviewed here. The subject has been detailed by various expert commitees and scientific groups, and comprehensive lists of the types of entomological activities in various phases of malaria eradication have been given in the Eleventh Report of the Expert Committee on Malaria (20) as well as in the Report of the Scientific Group on Mosquito Ecology (21).

In Iran, with a well developed country-wide malaria eradication programme, comprised of large areas in the stages of pre-maintenance (from malaria eradication point of view, but inadequacy of basic health services), early and late consolidation, early and late attack, both in responsive zones and non-responsive or refractory areas (subjected to problems such as

Since 1969, a Bilharziasis Pilot project has been est lished in the area, to study the epidemiology and experimen control of the disease and with a view of expanding cont operations throughout the infested area.

During this period, a system of surveillance (periodic m thly snail surveys) has been active within the area to study *truncatus* and the main factors related to this snail and inf encing the dynamics of transmission of the disease, they are (

3-1. SNAIL POPULATION PROPERTIES

(a) *Snail population and seasonal trends*

Snail density plays the most important role in the dy mics of transmission of a chistosomiasis. Although the minim density of snails required for continuation of transmission (tical density) is not available, experience indicates that tra mission of infection will be interrupted when the snail dens drops below certain levels. This may explain the reason transmission changes in various seasons of the year as indica by animal immersion studies in Iran in which the only infec animals found were those immersed in May when the density *B. truncatus* is maximum. Snail density is, in turn influen by seasonal changes of temperature, rainfall and ecolog factors such as the type of habitat of the snails.

The collection and population estimation of snails a egg masses were done at monthly intervals, using dip-nets (Oli and Schneindermann method) at marked sites (in ponds a pond-like swamps), passing nets at one meter intervals along longitudinal and lateral mid-lines (in large swamps), 30 n each passed at 1-meter intervals at 10 sites along each can or count made on the undersurface of 100 submerged ston 10 cm, to 20 cm. long.

(b) *Growth rate*

Growth rate is another factor influencing the populati density and the age structure of a snail colony and both (gro and age) are mostly dependent upon temperature variatio They can be determined by continuous measurement of size of snails collected from the field according to the meth described above. Those snails less than 6 mm long are con dered as young. The growth rate of an individual snail minimum (0.41 mm) in February, and maximum (1.7 mm) September.

(c) *Age specific mortality rates*

These can be calculated for snails in various habitats using the special formula described by Webbe (1964). It diff in various age groups and usually is affected by factors such as the degree of water pollution, over crowding, and the biotope of the habitat.

(d) *Age specific reproduction data*

Certainly the population structure and density of snails are influenced by the survival rate of young snails and the reproduction rate.

The age structure of the snail population in Iran is found to vary according to the seasons of the year, and also in various habitats at a given time. The longevity of Bulinus, which is about 12-18 months in the field and 12 months in the laboratory (experiences of Iran), depends upon the month of its hatching. Other factors such as average number of eggs, and egg-masses produced by each Bulinus, hatchability rate, the number of generations and offsprings per year, etc., are also important from ecological and epidemiological points of view.

3-2. INTERMEDIATE HOST - PARASITE RELATIONSHIP

One of the important factors influencing the dynamic of transmission is the relationship between the intermediate host and the parasite. It includes:

(a) Susceptibility to infection,
(b) snail infection rate and degree and pattern of cercarial production;
(c) daily output of cercariae and effect of infection upon the snail;
(d) duration of infection
(e) possible capacity of snail to keep the infection during aestivation period.

3-3. OTHER ECOLOGICAL FACTORS

Some other factors influencing transmission are :

(a) ability of snails to survive in dry mud;
(b) the effect of dessication on fecundity, breeding, etc;

3-4. OPERATIONAL AND ORGANIZA - TIONAL ASPECTS OF SANIL SURVEYS

In a national or regional mass campaign against bilharziasis after having collected the basic epidemiological information upon which the campaign is planned, there is need for the establishment of a system of "epidemiological and malacological watching or surveillance" in order to evalute the effectiveness of the campaign and to folow-up the features of the problems.

The malacological part of this system will reasonably include :

(a) The establishment of a net-work of surveillance for the regular periodic checking of all snail habitats, to determin

(1) The presence of snail vector
(2) Snail density and the pattern of changes
(3) Snail infection rate
(4) Relevant data in relation to the conditions of t snail habitats.

The set up of surveillance net-work and its organizati all depend on the size and the extent of the problem. In the ca of Bilharziasis infected areas of Iran, the establishment of fi teams, each consisting of two field technicans (with sufficie training in snail control and snail ecology) assisted by four labo rers (with enough skill and experience in snail collection and supervised by a senior technologist (with enough skill, knowled and experience in the field of malacology and snail control) ha been provided.

There is no need to emphasize that for the snail destru tion (through chemical or environmental sanitation metho other specified teams should collaborate.

3-5. THE ESTABLISHMENT OF A SPECIFIC EVALUATION AND WATCHING UNIT

This unit is necesary for watching, evaluating and surveying t Bilharziasis situation more in depth. All factors related to t snail ecology and as listed in the previous chapter will be studi by this unit within operational areas on sample basis or in hal tats found positive for vector snails by the previous teams.

In the case of Iran, The Bilharziasis Research Station the Institute of Public Health Research is carrying out the duties in parallel with other experiments and research progra mes which have been developed on the subject of Bilharzia and related fields.

4- RODENTS AND THEIR FLEAS

A focus of sylvatic plague is located in Kurdistan in the nort west of Iran. This focus is under continuous epidemiological i vestigation by the Pasteur Institute, and has been since 1947 wh an outbreak of human plague occurred in the area.

The method used by the Pasteur Institute of Iran for t surveillance of plague in this area is essentially based on bact riological examination of rodents and their fleas in this foc This surveillance is carried out for periodic assessment of t area for the presence of the plague in the area in the form yearly surveys of rodents and their fleas, the geographic exte of the disease and the relative densities of the mammals invol ed. (10) The technique used for this surveillance is briefly follows:

4-1. VISIT OF THE AREA

In the course of eight years of continuous study, biotopes of various rodent species of the area have been determined by aerial photographs. There exist ten species of rodents in this focus harbouring thirteen species of fleas out of which three species are dominant.

In each visit in a locality, the area will be carefully inspected using a topless jeep and travelling with a maximum speed of 20 kilometers per hour. Number of burrow openings and signs of activity of rodents will be recorded so that it is possible to determine abundance of holes with signs of activity; abundance of holes without signs of activity; scarcity of burrows with or without signs of activity, and so forth. In this way we can have some evidence of the stages of epizootics among rodents. (Beginning of epizootics, peak of epizootics, decline of epizootics, periode of quiescence and period of recrudescence).

4-2. COLLECTION OF RODENTS AND THEIR FLEAS

In Kurdistan conditions,the best traps for collection of rodents are wooden live traps. Each specimen captured is handled individually. At first fleas of the captured rodent are collected without delay and put in a small tube containing saline. The fleas are brought to the laboratory, along with the rodent. Each specimen is numbered in the field and data sheets are completed on the spot for important points such as trap site, ecological associations, sex, number of ectoparasites removed, date, etc. (8)

4-3. LABORATORY PROCEDURES

In the laboratory the animal is killed, immersed in kerosene and fixed on the dissection plate. Part of the spleen, and if necessary, a small part of the liver will be used for detection of plague bacilli. Fleas collected from each individual rodent will be used for detection of *Yersinia pestis* by culture and animal inoculation.

4-4. COLLECTION OF FLEAS FROM UNINHABITED BURROWS

Sometimes, at the end of epizootics among very susceptible species, large numbers of holes may be found without signs of activity. If members of these colonies had been dead less than 50 days before the visit, it is possible to isolate plague bacilli from the fleas of those burrows. Various techniques are used for collection of these fleas such as digging the burrow and collection of fleas from straws and dried grass of the nest, putting a petri dish full of water at the entrance of the burrow, pushing a plastic tube covered with while flannel inside the burrow and lastly, sending a laboratory mouse into the burrow for a while, having tied it with a nylon string around its waist, and collecting fleas from this animal after drawing it back out of the burrow. In any case, fleas will be put in a small tube of saline, taken to the laboratory and examined there for detection of plague bacilli.

4-5. EPIDMI - OLOGICAL IMPLICATION

The traditional flea index is not considered as a sensitive criterion in the case of sylvatic plague, so it is no more used in the Iranian studies. Up to 1966, the flea index was used as an epidemiological criterion, taking into account the index of more than "2" as an indication of danger. Now, the epizootical judgement is based on the observation for and finding of positive rodents and positive fleas (specially in the case of the two most prevalent species : *X. buxtoni and Nos. Iranus) for Y. pestis.*

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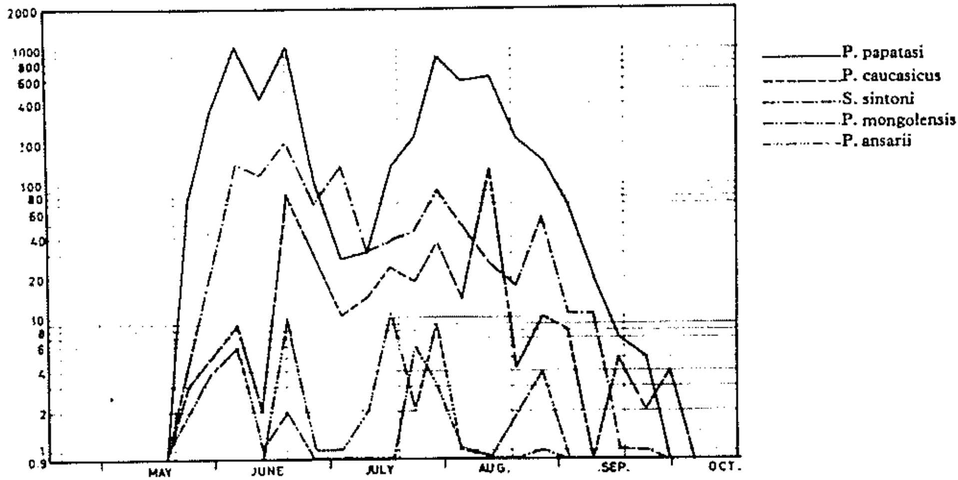
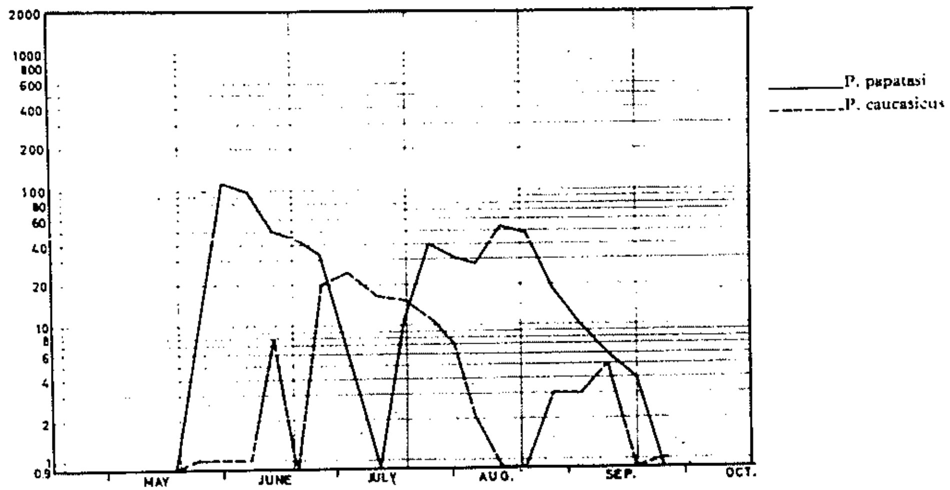
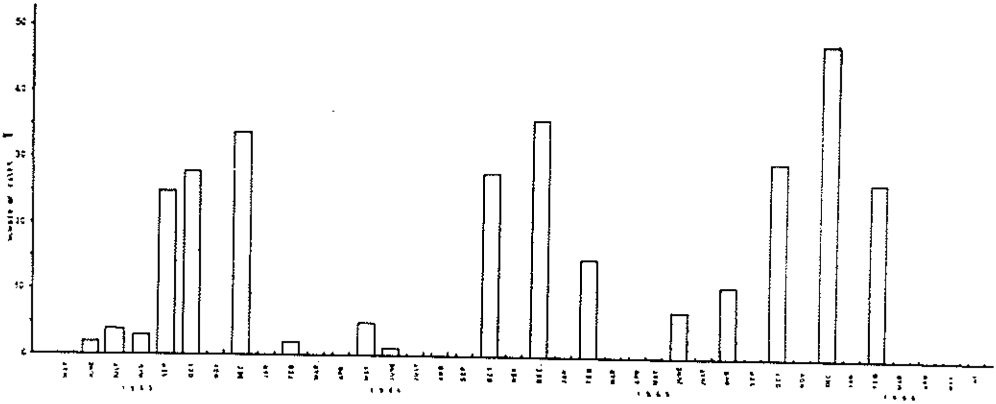


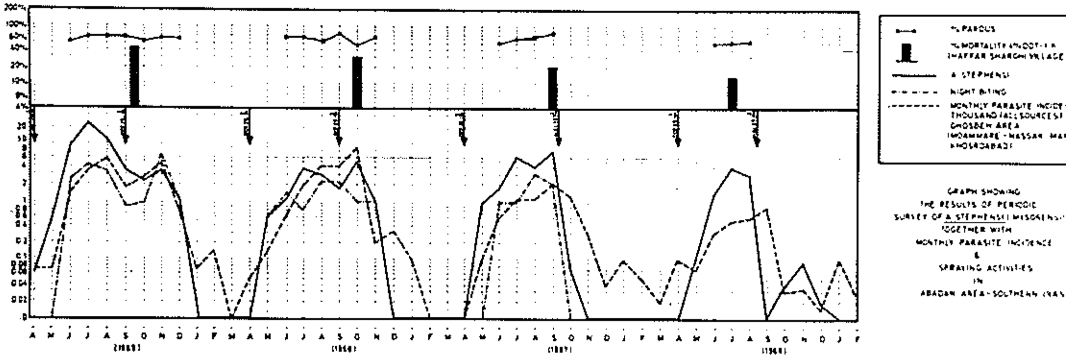
Graph showing the seasonal variations of the population of sandflies in Ali-Abad village in 1964. Capture by sticky traps from rodent holes. Weekly collection by 10 traps.



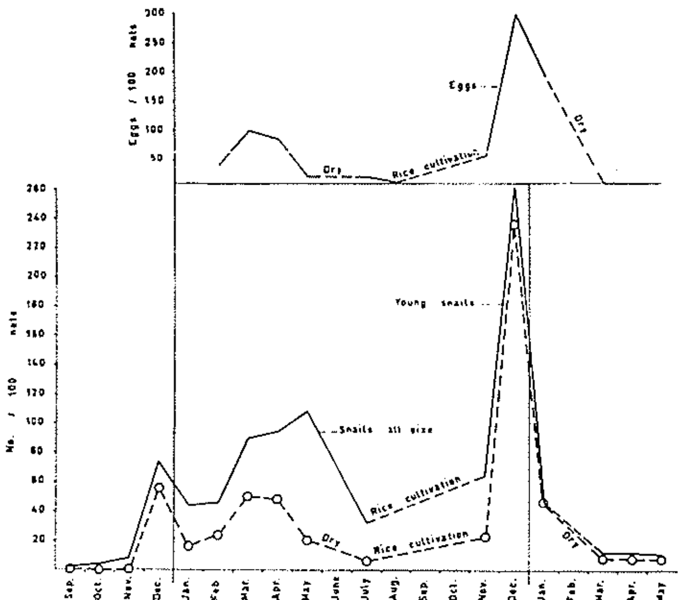
Graph showing the seasonal variations of the population of domestic sandflies in Ali-Abad village in 1964. Capture by Aspirator from rooms. Weekly collection in 10 rooms, 15 minutes in each.



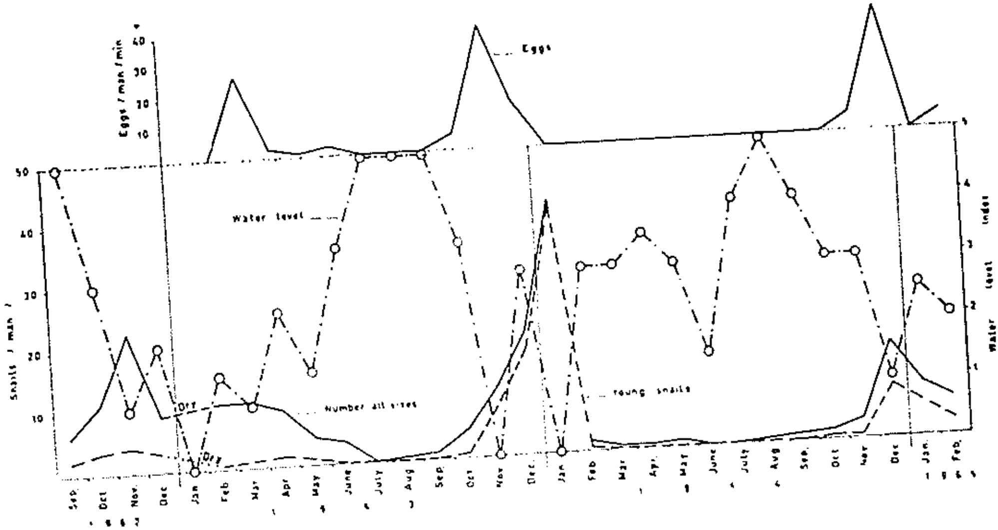
Studies on cutaneous leishmaniasis in Isfahan (June 1963 to June 1966). Bar-diagram showing seasonal variation of prevalence of oriental sore in 23 villages (7,000 population)



MONTHLY DENSITIES OF *BULINUS TRUNCATUS* ADULTS AND EGGS IN A KHOVAYES SWAMP



MONTHLY DENSITIES OF *BULINUS TRUNCATUS* ADULTS AND EGGS AND FLUCTUATIONS IN WATER LEVEL IN A QALEH SHEIKH POND



MONTHLY DENSITIES OF *BULINUS TRUNCATUS* ADULTS AND EGGS AND FLUCTUATIONS OF WATER LEVEL IN A SMALL QALEH ABAD SHAH SWAMP